Discrete Element Modelling of Unreinforced Masonry Buildings and Parts

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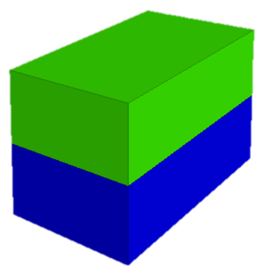
ITASCA

3DEC™ VERSION 5.2 Distinct-Element Modeling of Jointed and Blocky Material in 3D

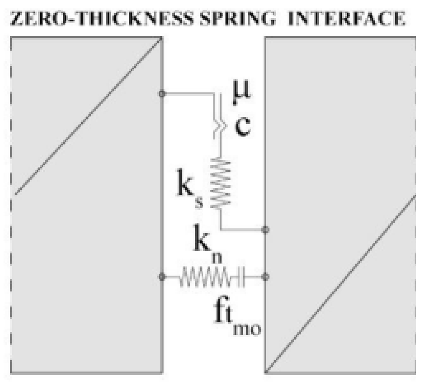
QuakeCoRE NZ Centre for Earthquake Resilience

THE UNIVERSITY OF AUCKLAND NEW ZEALAND Te Whare Wānanga o Tāmaki Makaurau

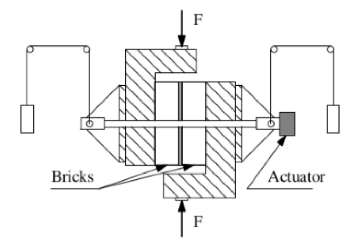
Post-earthquake inspections have highlighted that out-of-plane failure of unreinforced masonry (URM) walls is one of the most life threatening hazards related to earthquakes. Connections between structural elements and interlocking across the wall section play an important role in the capacity of a URM building to withstand earthquakes. Consequently, the seismic assessment of existing URM buildings requires an appropriate methodology to correctly estimate the performance of the investigated element. International standards and guidelines for seismic assessment are often based on simplified methodologies that incorporate assumptions regarding the collapse mechanism and general behaviour of the wall. Alternatively, the Discrete Element Method (DEM) is an advanced modelling technique that can accurately predict and simulate from wall behaviour to full scale buildings without any prior assumption about the failure mechanism. Solid rigid and deformable elements were used to represent the distinct clay brick units and an inelastic law was assigned to the contact surfaces to simulate the mortar joints. Pushover and non-linear time history analyses were conducted and the resultant capacity curves and collapse mechanisms of each analysis were studied.

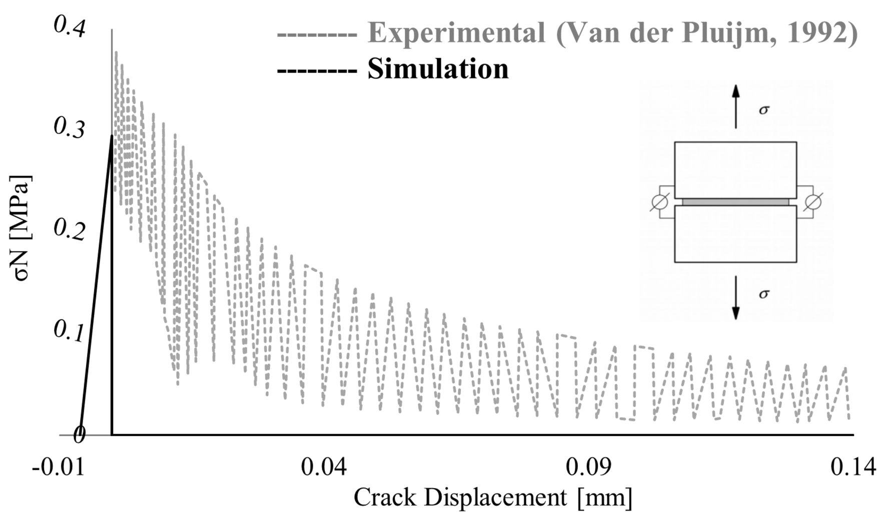


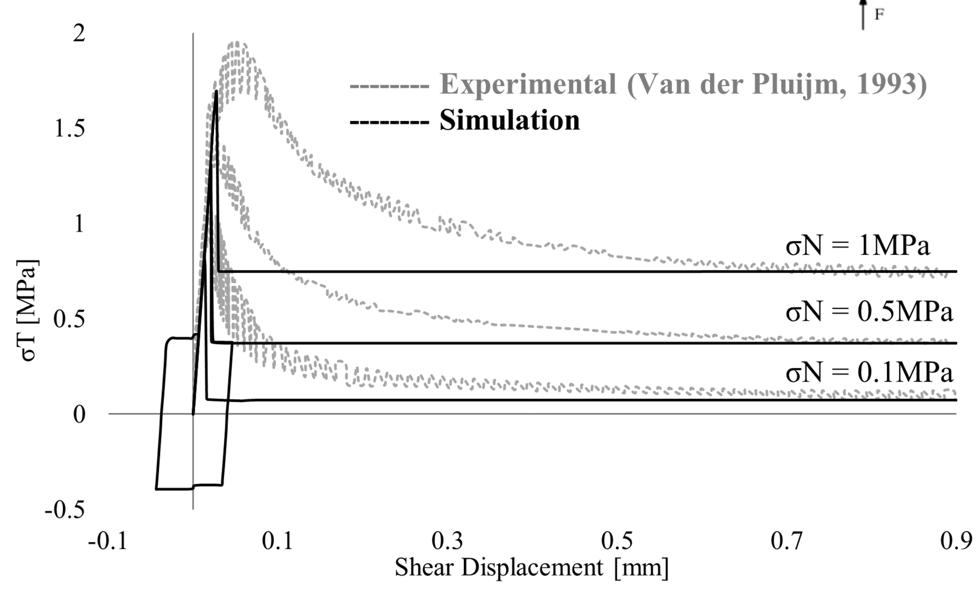
- Normal Stiffness (kn)
- Shear Stiffness (ks)
- Friction Coefficient (μ)
- Cohesion (c)
- Tensile Strength (ft)



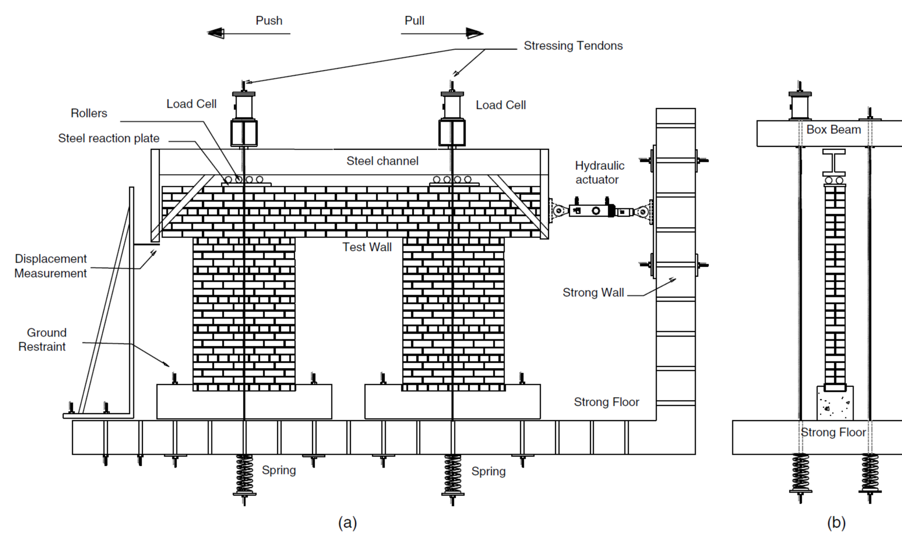
Malomo et al, (2018)

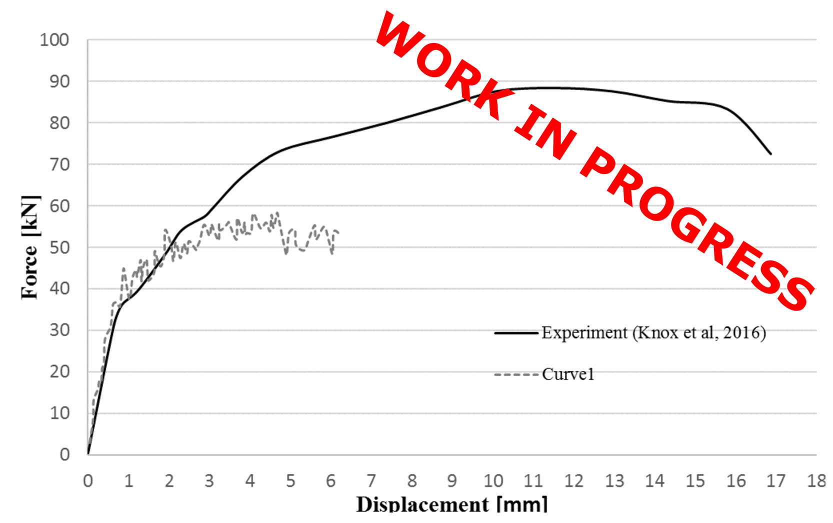


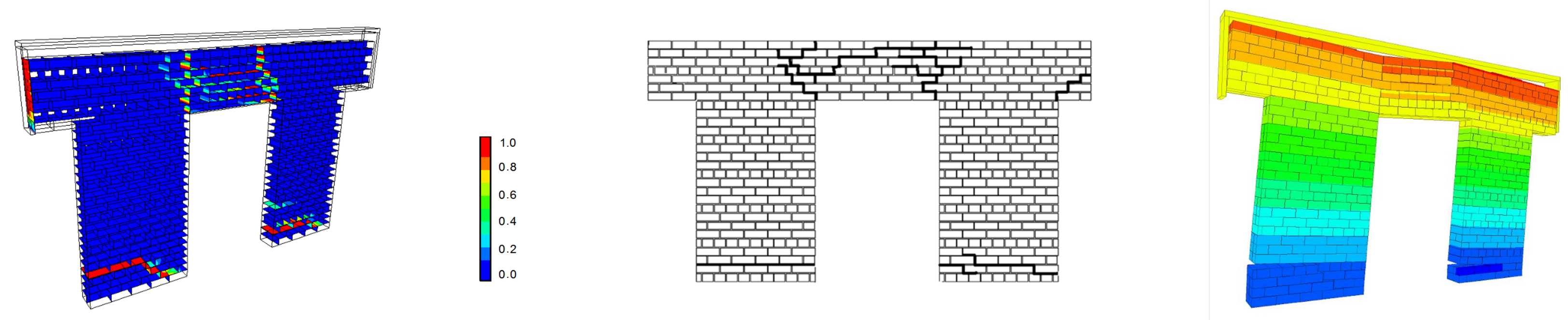




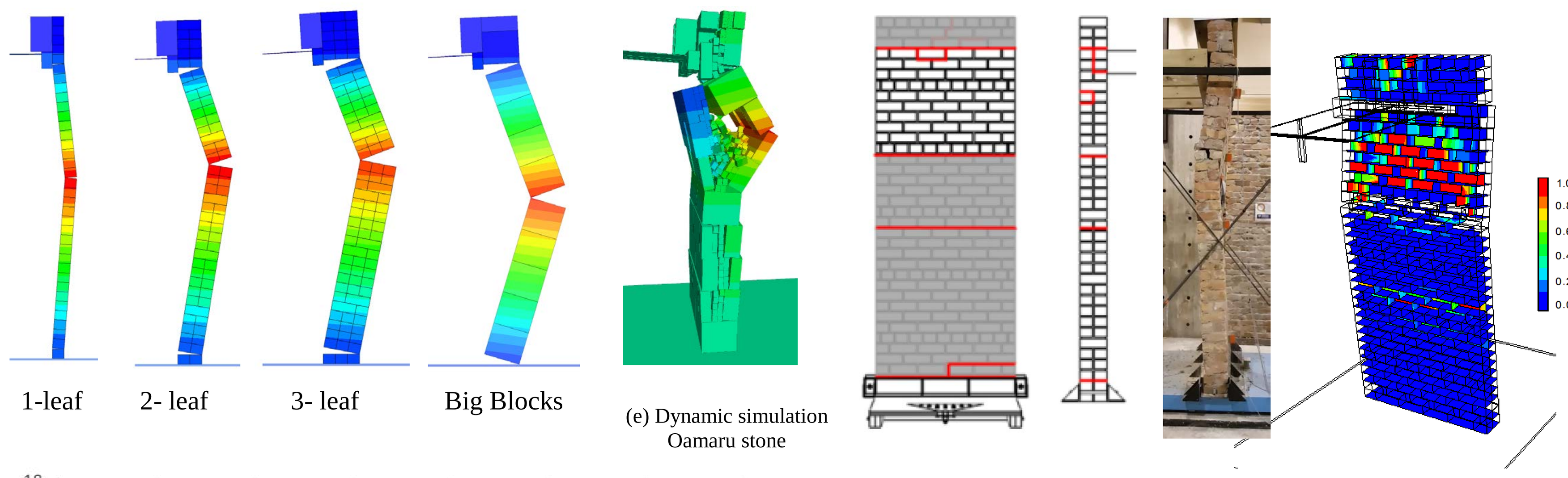
Couplet Models

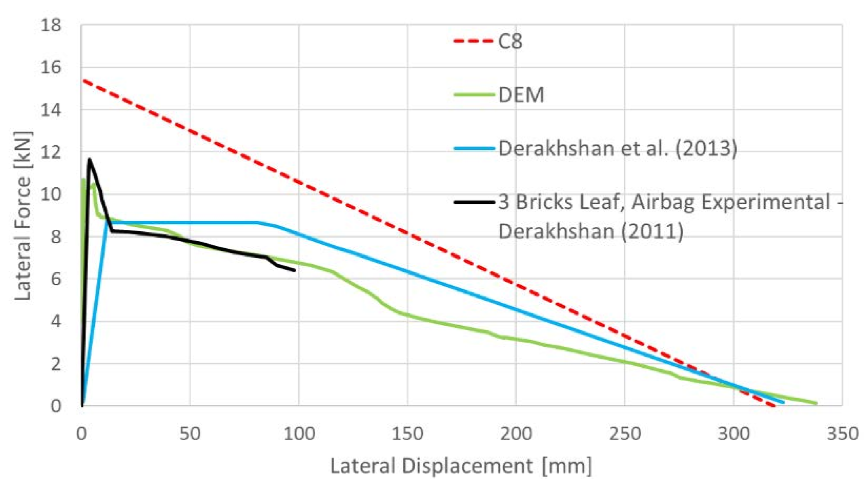




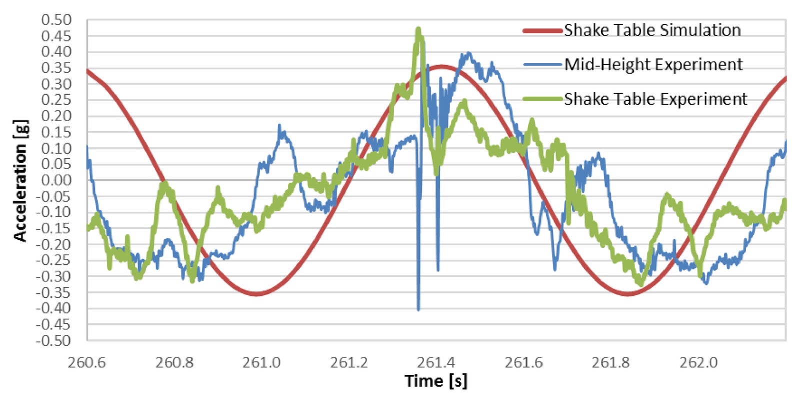


Cyclic in-plane test of pier-spandrel substructure



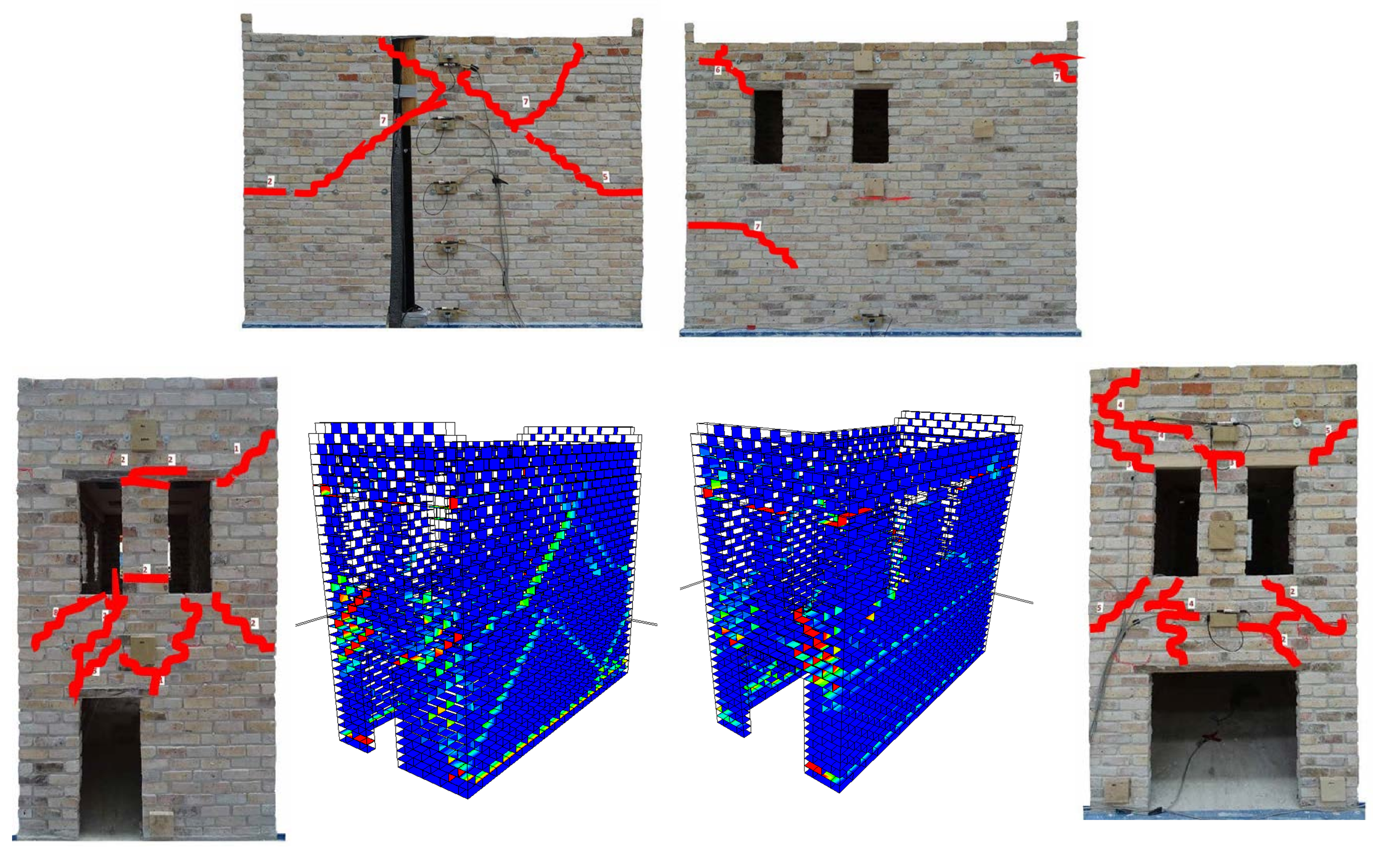


Comparison of test, simulation and analytical formulations applied to 3 leaf thick clay brick URM wall

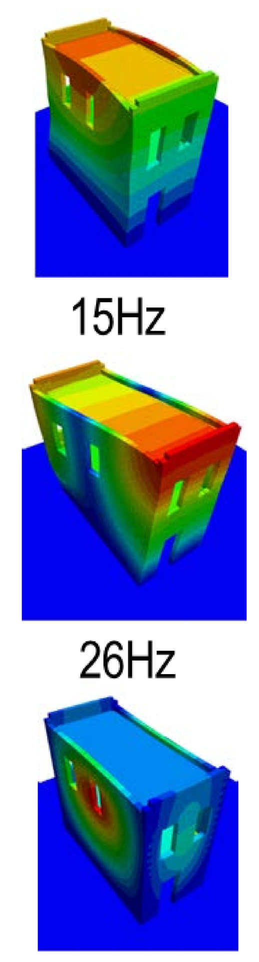


Acceleration of the pulse immediately before total collapse

Dynamic and quasistatic One-way bending walls



Crack comparison between DEM model and experiment

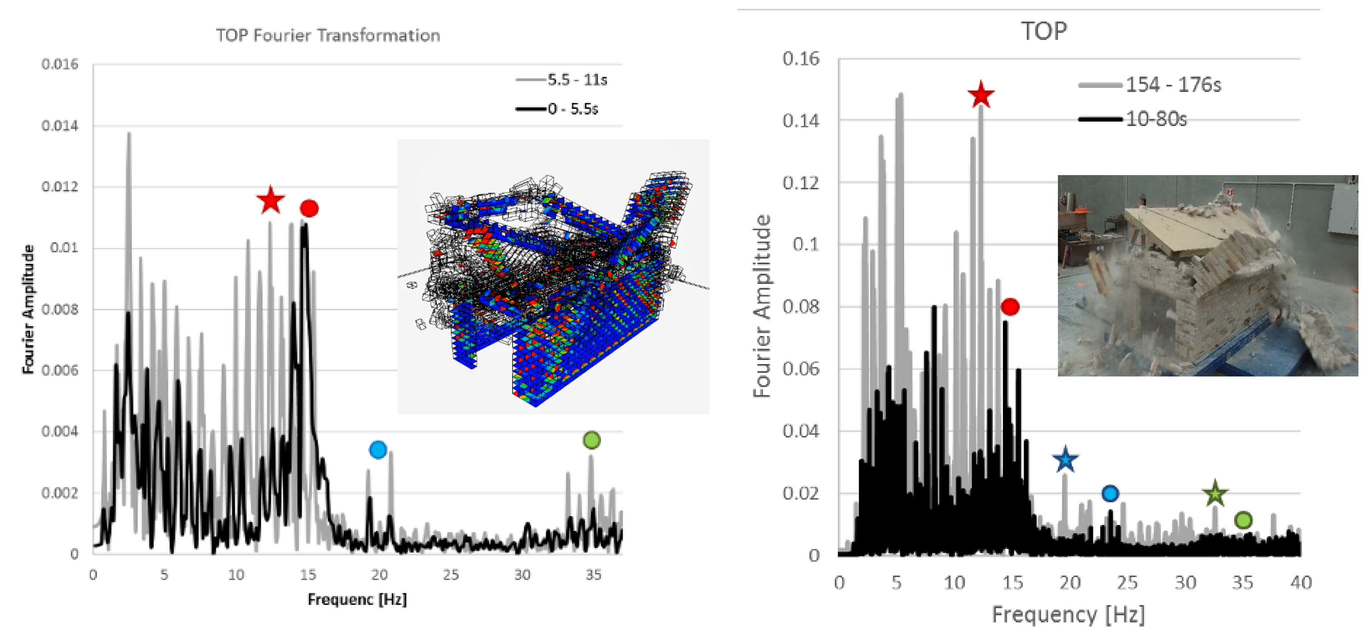


15Hz

26Hz

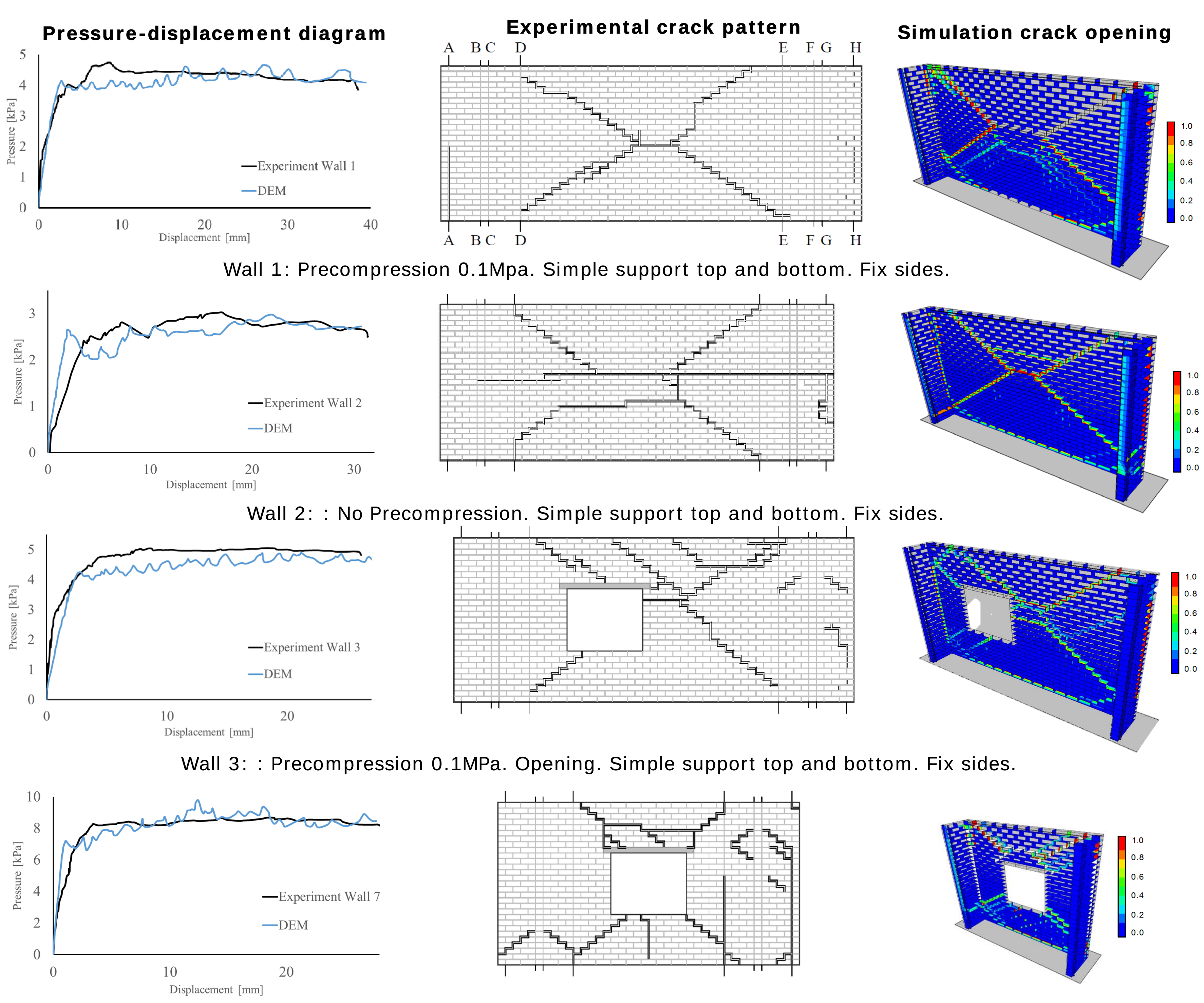
35Hz

Eigenvalue analysis



Fourier Amplitude Spectra (Star: Initial; Circle: Damaged)

Shake table 2-storey scaled model



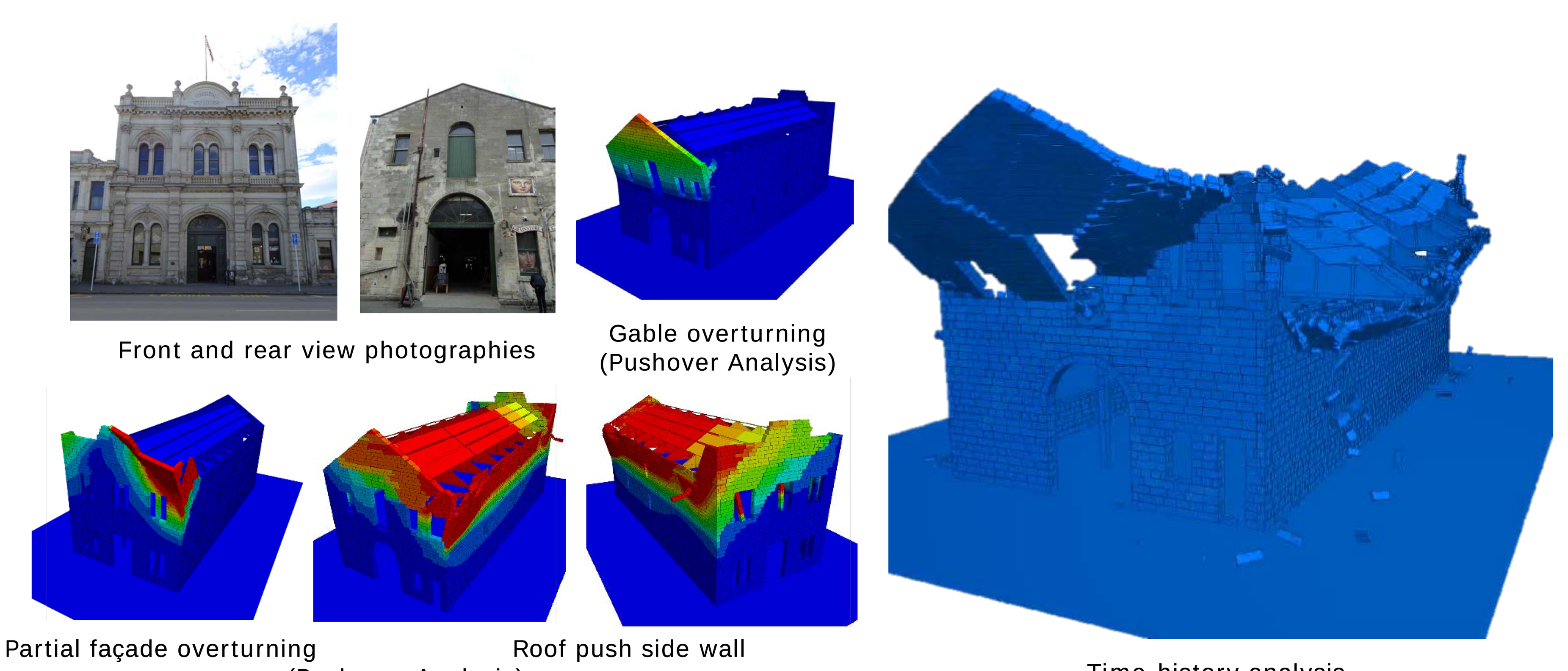
Wall 1: Precompression 0.1Mpa. Simple support top and bottom. Fix sides.

Wall 2: : No Precompression. Simple support top and bottom. Fix sides.

Wall 3: : Precompression 0.1MPa. Opening. Simple support top and bottom. Fix sides.

Wall 7 Precompression 0.1MPa. Opening. Simple support top and bottom. Fix sides.

Two-way bending walls



Front and rear view photographies

Gable overturning (Pushover Analysis)

Partial façade overturning

Roof push side wall

(Pushover Analysis)

Time-history analysis

Full-scale warehouse collapse mechanisms